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EFFECT OF INTEGRATED WEED MANAGEMENT PRACTICES ON GROWTH, NODULATION, YIELD AND QUALITY OF MUNGBEAN (*Vigna radiata* L. R. WILCZEK)

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ABSTRACT

A field experiment was conducted during *Kharif* 2024 at the Instructional Farm, College of Agriculture, Agriculture University, Jodhpur to evaluate the effect of integrated weed management practices on growth, yield, and quality of mungbean under semi-arid conditions. The experiment was laid out in a Randomized Block Design with ten treatments replicated thrice. Among the treatments, weed-free treatment (T_7) recorded significantly superior growth and yield attributes, including maximum plant height at harvest (58.84 cm), dry matter accumulation (22.46 g/plant), branches (7.76/plant), nodules (23.53/plant), pods (36.43/plant), grains/pod (10.27), and test weight (42.09 g). It also produced the highest grain yield (1292 kg/ha), stover yield (2084 kg/ha), biological yield (3376 kg/ha), harvest index (38.27%), protein content (24.62%), and protein yield (318 kg/ha). However, among weed management treatments, fluazifop-p-butyl 11.1% + fomesafen 11.1% SL @ 220 g/ha at 20 DAS followed by hand weeding at 30 DAS (T_6) proved most effective, recording grain yield of 1214 kg/ha and harvest index of 37.17%, which was 56.84% higher than weedy check. The weedy check (T_1) recorded the lowest values for growth and yield parameters, including plant height (46.43 cm), grain yield (774 kg/ha), biological yield (2301 kg/ha), protein content (21.43%), and protein yield (166 kg/ha). Integrated weed management practices involving herbicides combined with hand weeding effectively reduced crop-weed competition and improved productivity and quality of mungbean under semi-arid conditions.

Key words : Mungbean, Integrated weed management, Fluazifop-p-butyl, Fomesafen, Sorgaab, Grain yield, Protein content.

Introduction

Mungbean, commonly known as green gram, is an important pulse crop widely cultivated in the arid and semi-arid regions of India. It belongs to the family Fabaceae and is valued for its high nutritional quality, containing about 24–25% protein along with carbohydrates, minerals and fats. Being a leguminous crop, mungbean improves soil fertility through biological nitrogen fixation and contributes significantly to sustainable agriculture and nutritional security (Bangar *et al.*, 2019 and Hayat *et al.*, 2008).

India is the leading producer of mungbean, cultivating it over a large area with Rajasthan as the major producing state. Despite its importance, productivity remains low

due to factors such as weed infestation, drought, diseases, lack of improved varieties and poor crop management practices. Among these, weeds are one of the most serious constraints causing substantial yield losses in mungbean, particularly during the early growth stages. Yield reductions ranging from 10 to 45% due to weed competition have been reported by Raj *et al.* (2012), while Mehriya and Shukla (2015) observed losses up to 45.8%. Severe weed infestation during the critical crop growth period can drastically reduce grain yield (Sheoran *et al.*, 2008 and Verma *et al.*, 2015).

The weed flora associated with mungbean varies according to agro-climatic conditions and soil types. Studies conducted at Jodhpur by Jat and Singh (2021)

reported the dominance of grassy weeds such as *Cenchrus biflorus* and *Brachiaria ramosa*, along with broad-leaved weeds and sedges like *Cyperus rotundus*. Effective weed management during the critical crop-weed competition period is therefore essential for achieving higher productivity.

Chemical weed control using herbicides such as imazethapyr, imazamox, and clodinafop-propargyl has been found effective in managing weeds in mungbean. In addition, allelopathic approaches using sorghum extracts (Sorgaab) have shown promising results in suppressing weed growth. Sorghum contains several allelochemicals, including phenolics, flavonoids, alkaloids, and terpenoids, which possess phytotoxic effects against weeds (Jabran *et al.*, 2015 and Pagare *et al.*, 2015). Studies revealed that sorghum water extracts significantly reduced weed density and dry matter accumulation while improving mungbean yield (Cheema *et al.*, 2001).

Integrated Weed Management (IWM), involving the combined use of cultural, mechanical, chemical, and allelopathic methods, is considered an efficient and economical strategy for weed control in mungbean. Such integrated approaches help minimize herbicide dependence, reduce environmental pollution and herbicide resistance, improve weed control efficiency, and enhance crop productivity. Therefore, timely and integrated weed management practices are essential for sustaining higher mungbean yields under semi-arid conditions (Ayansina *et al.*, 2003).

Materials and Methods

A field experiment was conducted during the *Kharif* 2024 season at the Instructional Farm, College of Agriculture, Agriculture University, Jodhpur. The experimental site is situated at 26.25°N latitude and 73.02°E longitude with an altitude of 231 m above mean sea level. The region experiences a semi-arid climate marked by high temperatures, irregular rainfall, and low humidity. The experimental soil was sandy loam in texture, alkaline in reaction (pH 8.2), low in organic carbon and available nitrogen, while medium in available phosphorus and potassium. The experiment was laid out in a Randomized Block Design (RBD) comprising ten weed management treatments replicated thrice. The treatments included weedy check, weed-free condition, application of Sorgaab, herbicide mixtures integrated with hand weeding, and combinations of herbicides with Sorgaab application. Different ready-mix herbicides such as sodium-acifluorfen + clodinafop-propargyl, fluazifop-p-butyl + fomesafen, and imazethapyr + imazamox were evaluated either with hand weeding or allelopathic

application of Sorgaab.

Mungbean [Mungbean] variety GM-4 was used as the test crop. Sowing was done manually in rows spaced 30 cm apart with 10 cm plant spacing using a seed rate of 15 kg/ha. A recommended basal fertilizer dose of 15 kg nitrogen and 40 kg P₂O₅ per hectare was applied uniformly. All other agronomic and cultural practices were maintained uniformly throughout the experiment.

Various growth, yield and quality parameters of mungbean were recorded during the experiment. Plant population was counted at 20 DAS and at harvest, and values were converted into plants per hectare. Plant height, number of branches, and dry matter accumulation were measured from five tagged plants at 30, 45 DAS, and harvest. Dry matter was determined after oven drying plant samples at 65 ± 1°C until constant weight was obtained.

Nodulation studies included counting the number of nodules per plant along with recording fresh and dry weight of nodules at flowering and harvest stages. Nodules were carefully uprooted, cleaned, weighed fresh, and then oven-dried to obtain dry weight.

Yield attributes such as number of pods per plant, grains per pod, and 1000-grain weight were recorded at harvest using randomly selected plant and pod samples. Grain yield was determined from cleaned produce after adjusting seed moisture to 12 per cent and expressed in kg/ha. Stover yield was calculated by subtracting grain yield from biological yield, while biological yield was recorded from the total sun-dried produce of the net plot. Harvest index was calculated as the ratio of grain yield to biological yield and expressed in percentage.

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield (kg/ha)}}{\text{Biological yield (kg/ha)}} \times 100$$

Quality parameters included protein content and protein yield. Protein content in grains was estimated by multiplying nitrogen percentage by 6.25 (A.O.A.C., 1960), while protein yield was calculated based on protein content and grain yield.

$$\text{Protein yield} = \frac{\text{Protein content in seed (\%)} \times \text{Seed yield (kg/ha)}}{100}$$

Results and Discussion

Growth attributes

Plant population

The various weed management practices had no significant influence on the plant population (Fig. 1) at 20 DAS and at harvest stage. The numerically higher value of plant population at 20 DAS and at harvest stage was

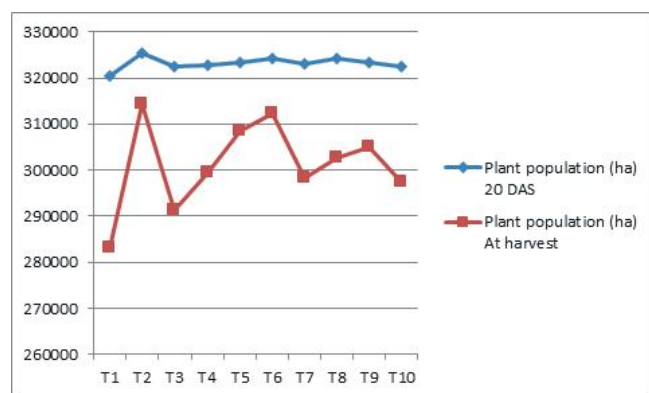


Fig. 1 : Plant population at 20 DAS and at harvest of mungbean as influenced by different weed management practices.

fomesafen @ 220 g/ha + hand weeding (T_6), which remained statistically at par with other integrated weed management treatments. The lowest plant height (7.64 cm) was observed under weedy check (T_1).

At 45 DAS, weed-free treatment (T_2) again recorded the tallest plants (40.52 cm), which was statistically comparable with T_6 , T_5 , T_9 and T_4 treatments. The minimum plant height (31.02 cm) was recorded under weedy check (T_1).

At harvest, significantly higher plant height was observed under weed-free treatment (58.84 cm), which remained at par with T_6 , T_5 , T_9 and T_4 treatments,

Table 1 : Plant height at different growth stages of mungbean as influenced by different weed management practices.

Treatments	Plant height (cm)		
	30 DAS	45 DAS	At harvest
(T_1) Weedy check	7.64	31.02	46.43
(T_2) Weed free	11.06	40.52	58.84
(T_3) Sorgaab @ 10 lit/ha (2:10) at 20 and 30 DAS	8.32	34.96	51.74
(T_4) Sorgaab @ 10 lit/ha (2:10) at 20 DAS + H.W. at 30 DAS	8.36	37.74	54.72
(T_5) Acifluorfen 16.5% + clodinafop 8% @ 210 g/ha at 20 DAS + H.W. at 30 DAS	8.86	38.17	55.42
(T_6) Fomesafen 11.1% + fluazifop-p-butyl 11.1% @ 220 g/ha at 20 DAS + H.W. at 30 DAS	9.18	39.48	56.94
(T_7) Acifluorfen 16.5% + clodinafop 8% @ 210 g/ha at 20 DAS + Sorgaab conc. @ 10 lit/ha (2:10) at 30 DAS	8.79	36.81	52.49
(T_8) Fomesafen 11.1% + fluazifop 11.1% + Sorgaab conc. @ 10lit/ha (2:10) at 30 DAS	9.22	37.18	53.28
(T_9) Imazethapyr 35%+imazamox 35% @ 70 g/ha at 20 DAS + H.W. at 30 DAS	8.67	37.92	55.17
(T_{10}) Imazethapyr 35% + imazamox 35% @ 70 g/ha at 20 DAS + Sorgaab conc. @ 10 lit/ha (2:10) at 30 DAS	8.61	36.67	52.29
SEm±	0.27	1.23	1.73
CD(P=0.05)	0.82	3.68	5.16

recorded under weed free treatment (3,25,316/ha) and (3,14,305/ha), respectively. due to season-long weeding that favors better growth and development of mungbean during the study. These results are in close conformity with the findings of Mirijha *et al.* (2013) and Singh *et al.* (2014).

Plant height (cm)

Different weed management practices significantly influenced the plant height (Table 1) of mungbean at 30, 45 DAS and at harvest. At 30 DAS, the weed-free treatment (T_2) recorded the highest plant height (11.06 cm), followed by fluazifop-p-butyl + fomesafen @ 220 g/ha at 20 DAS + sorgaab (T_8) and fluazifop-p-butyl +

recording 56.94, 55.42, 55.17 and 54.72 cm plant height, respectively. The shortest plants (46.43 cm) were recorded under weedy check (T_1). Overall, integrated weed management practices involving herbicides combined with hand weeding or sorgaab application enhanced plant growth compared to weedy check. Less competition between mungbean and weeds for nutrients, mainly nitrogen, phosphate, and potash, as well as other resources like space, light, and water, all of which are necessary in sufficient amounts for healthy growth and development, may lead to taller mungbean plants. Chugh *et al.* (2017) Dhaker *et al.* (2010) and Vyvhare *et al.* (2023).

Table 2 : Dry matter accumulation (g/plant) of mungbean as influenced by different weed management practices.

Treatments	Dry matter accumulation (g/plant)		
	30 DAS	45 DAS	At harvest
(T ₁) Weedy check	1.81	4.21	11.94
(T ₂) Weed free	3.13	12.34	22.46
(T ₃) Sorgaab @ 10 lit/ha (2:10) at 20 and 30 DAS	2.18	6.86	13.96
(T ₄) Sorgaab @ 10 lit/ha (2:10) at 20 DAS + H.W. at 30 DAS	2.16	9.02	17.94
(T ₅) Acifluorfen 16.5% + clodinafop 8% @ 210 g/ha at 20 DAS + H.W. at 30 DAS	2.41	10.63	19.33
(T ₆) Fomesafen 11.1 % + fluazifop-p-butyl 11.1 % @ 220 g/ha at 20 DAS + H.W. at 30 DAS	2.59	11.48	21.14
(T ₇) Acifluorfen 16.5% + clodinafop 8% @ 210 g/ha at 20 DAS + Sorgaab conc. @ 10 lit/ha (2:10) at 30 DAS	2.35	9.08	16.67
(T ₈) Fomesafen 11.1 % + fluazifop 11.1% + Sorgaab conc. @ 10lit/ha (2:10) at 30 DAS	2.52	9.21	17.76
(T ₉) Imazethapyr 35% + imazamox 35% @ 70g/ha at 20 DAS + H.W. at 30 DAS	2.29	9.93	18.87
(T ₁₀) Imazethapyr 35 % + imazamox 35 % @ 70 g/ha at 20 DAS + Sorgaab conc. @ 10 lit/ha (2:10) at 30 DAS	2.21	8.91	16.08
SEm±	0.13	0.46	0.75
CD (P=0.05)	0.39	1.37	2.22

Dry matter accumulation (g/plant)

Different weed management practices significantly influenced dry matter accumulation (Table 2) of mungbean at various growth stages, and dry matter increased progressively up to harvest. At 30 DAS, the weed-free treatment recorded the highest dry matter accumulation (3.13 g/plant), followed by fluazifop-p-butyl + fomesafen @ 220 g/ha at 20 DAS + hand weeding at 30 DAS (T₆) with 2.59 g/plant. The lowest dry matter accumulation (1.81 g/plant) was observed under weedy check (T₁), while among weed management treatments, the minimum was recorded under sorgaab + hand weeding (T₄) (2.16 g/plant).

At 45 DAS, weed-free treatment again recorded significantly maximum dry matter accumulation (12.34 g/plant), which remained statistically at par with T₆ (11.48 g/plant). The lowest dry matter accumulation (4.21 g/plant) was noted under weedy check (T₁).

At harvest, weed-free treatment recorded the highest dry matter accumulation (22.46 g/plant), which was statistically at par with T₆ (21.14 g/plant). The least dry matter accumulation was observed under weedy check (T₁). Overall, integrated weed management treatments involving herbicides combined with hand weeding performed better in enhancing dry matter accumulation compared to herbicide + sorgaab treatments and weedy

check. Among treatments, T₆ showed superior performance followed by T₅, T₉ and T₄ across most growth stages.

Total number of branches (Nos./plant)

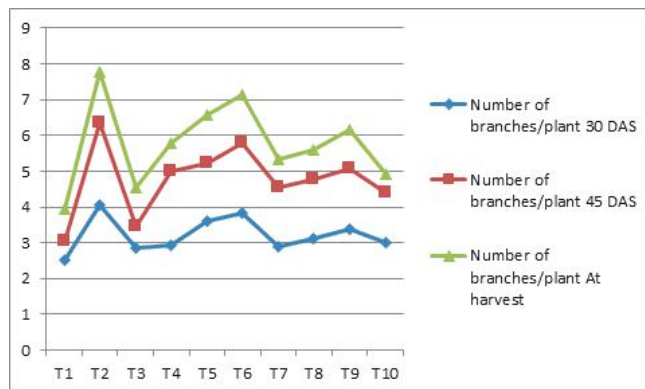
Different weed management practices significantly influenced the number of branches per plant (Fig. 2) in mungbean at all growth stages. At 30 DAS, weed-free treatment recorded the maximum branches (4.06/plant), while among weed management treatments, fluazifop-p-butyl + fomesafen @ 220 g/ha + hand weeding (T₆) produced the highest branches (3.84/plant). At 45 DAS and at harvest, weed-free treatment again recorded the highest number of branches (6.33 and 7.76/plant, respectively), remaining statistically at par with T₆ and T₅ treatments. The lowest number of branches was observed under weedy check (T₁), whereas among weed management practices, minimum branches were recorded under sorgaab application at 20 and 30 DAS (T₃). Overall, integrated weed management treatments involving herbicides combined with hand weeding improved branching in mungbean compared to weedy check. Chandolia *et al.* (2010) and Udhaya *et al.* (2023) both reported similar findings.

Symbiotic studies

Different weed management practices significantly influenced nodulation and nodule biomass (Table 3) of

Table 3 : Number of nodules, fresh and dry weight of nodules/plant at flowering stage of mungbean as influenced by different weed management practices.

Treatments	Nodules (No./plant)	Fresh weight (mg/plant)	Dry weight (mg/plant)
(T ₁) Weedy check	21.73	221.84	54.11
(T ₂) Weed free	36.22	398.34	98.73
(T ₃) Sorgaab @ 10 lit/ha (2:10) at 20 and 30 DAS	24.76	297.61	68.67
(T ₄) Sorgaab @ 10 lit/ha (2:10) at 20 DAS + H.W. at 30 DAS	30.23	359.73	79.22
(T ₅) Acifluorfen 16.5 % + clodinafop 8 % @ 210 g/ha at 20 DAS + H.W. at 30 DAS	31.97	371.78	84.36
(T ₆) Fomesafen 11.1% + fluazifop-p-butyl 11.1% @ 220 g/ha at 20 DAS + H.W. at 30 DAS	33.23	387.47	89.04
(T ₇) Acifluorfen 16.5% + clodinafop 8% @ 210 g/ha at 20 DAS + Sorgaab conc. @ 10 lit/ha (2:10) at 30 DAS	28.78	342.66	74.61
(T ₈) Fomesafen 11.1 % + fluazifop 11.1% + Sorgaab conc. @ 10lit/ha (2:10) at 30 DAS	29.89	351.34	76.86
(T ₉) Imazethapyr 35% + imazamox 35% @ 70 g/ha at 20 DAS + H.W. at 30 DAS	31.41	366.24	83.37
(T ₁₀) Imazethapyr 35 % + imazamox 35 % @ 70 g/ha at 20 DAS + Sorgaab conc. @ 10 lit/ha (2:10) at 30 DAS	27.84	327.83	79.85
SEm±	1.40	15.36	3.61
CD(P=0.05)	4.16	45.66	10.74

**Fig. 2 :** Total number of branches/plant at various stages of crop growth as influenced by different weed management practices.

mungbean at flowering and harvest stages. At flowering stage (40 DAS), the weed-free treatment (T₂) recorded the highest number of nodules (36.22/plant), fresh weight (398.34 mg/plant) and dry weight of nodules (98.73 mg/plant), which remained statistically at par with fluazifop-p-butyl + fomesafen @ 220 g/ha + hand weeding (T₆) recording 33.23 nodules/plant, 387.47 mg fresh weight and 89.04 mg dry weight of nodules. Sodium-acifluorfen + clodinafop-propargyl + hand weeding (T₅) also performed well with 31.97 nodules/plant, 371.78 mg fresh weight and 84.36 mg dry weight of nodules. In contrast, the weedy check (T₁) recorded the minimum nodules

(21.73/plant), fresh weight (221.84 mg/plant) and dry weight (54.11 mg/plant).

At harvest, weed-free treatment again recorded maximum nodules (23.53/plant), fresh weight (181.12 mg/plant) and dry weight (39.65 mg/plant), which remained at par with T₆ and T₅ treatments. The weedy check recorded the lowest nodules (13.92/plant), fresh weight (102.36 mg/plant) and dry weight (20.33 mg/plant). Overall, integrated weed management practices involving herbicides combined with hand weeding improved symbiotic activity and nodule development compared to weedy check and sorgaab-only treatments. Similar findings were reported by Raman and Krishnamoorthy (2005), Kumar *et al.* (2016) and Dhayal *et al.* (2022).

Yield attributes

Different weed management practices significantly influenced the yield attributes (Table 4) of mungbean. The weed-free treatment (T₂) recorded the highest number of pods/plant (36.43), grains/pod (10.27) and 1000-grain weight (42.09 g), which remained statistically at par with fluazifop-p-butyl + fomesafen @ 220 g/ha + hand weeding at 30 DAS (T₆), sodium-acifluorfen + clodinafop-propargyl + hand weeding (T₅) and imazethapyr + imazamox + hand weeding (T₉). Treatment T₆ recorded 35.03 pods/plant, 9.73 grains/pod and 41.28 g test weight, while T₅ produced 33.57 pods/plant, 9.40

Table 4 : Yield attributes of mungbean as influenced by different weed management practices.

Treatments	No.of pods/ plant	No.of grains/ pod	1000-grains weight(g)
(T ₁) Weedy check	24.61	7.93	37.08
(T ₂) Weed free	36.43	10.27	42.09
(T ₃) Sorgaab @ 10 lit/ha (2:10) at 20 and 30 DAS	28.21	8.13	37.88
(T ₄) Sorgaab @ 10 lit/ha (2:10) at 20 DAS + H.W. at 30 DAS	32.06	9.13	39.27
(T ₅) Acifluorfen 16.5% + clodinafop 8% @ 210 g/ha at 20 DAS + H.W. at 30 DAS	33.57	9.40	40.34
(T ₆) Fomesafen 11.1% + fluazifop-p-butyl 11.1% @ 220 g/ha at 20 DAS + H.W. at 30 DAS	35.03	9.73	41.28
(T ₇) Acifluorfen 16.5% + clodinafop 8% @ 210 g/ha at 20 DAS + Sorgaab conc. @ 10 lit/ha (2:10) at 30 DAS	31.24	8.80	39.09
(T ₈) Fomesafen 11.1 % + fluazifop 11.1 % + Sorgaab conc. @ 10lit/ha (2:10) at 30 DAS	31.66	8.93	39.21
(T ₉) Imazethapyr 35% + imazamox 35% @ 70 g/ha at 20 DAS + H.W. at 30 DAS	32.69	9.20	40.02
(T ₁₀) Imazethapyr 35 % + imazamox 35% @ 70 g/ha at 20 DAS + Sorgaab conc. @ 10 lit/ha (2:10) at 30 DAS	30.18	8.67	38.47
SEm±	1.35	0.37	0.99
CD (P=0.05)	4.02	1.11	2.97

grains/pod and 40.34 g test weight. Among sorgaab-based treatments, T₄ also recorded satisfactory performance with 32.06 pods/plant. In contrast, the weedy check (T₁) recorded the lowest yield attributes with 24.61 pods/plant and 7.93 grains/pod. Overall, integrated weed management practices involving herbicides combined with hand weeding improved reproductive growth and yield attributes of mungbean compared to weedy check. Significantly lower yield attributes were shown by Mirjha *et al.* (2013) and Singh *et al.* (2014).

Yield

Different weed management practices significantly influenced grain, stover and biological yield (Table 5) of mungbean. The weed-free treatment (T₂) recorded the maximum grain yield (1292 kg/ha), stover yield (2084 kg/ha), biological yield (3376 kg/ha) and harvest index (38.27%), which remained statistically at par with fluazifop-p-butyl + fomesafen @ 220 g/ha at 20 DAS + hand weeding at 30 DAS (T₆), sodium-acifluorfen + clodinafop-propargyl + hand weeding (T₅) and imazethapyr + imazamox + hand weeding (T₉). Among weed management treatments, T₆ produced the highest grain yield (1214 kg/ha) and harvest index (37.17%), followed by T₅ and T₉. The increase in grain yield under T₆ over weedy check was 56.84%. Similarly, higher stover and biological yields were also recorded under T₆, T₅ and T₉ treatments. In contrast, the weedy check (T₁)

recorded the lowest grain yield (774 kg/ha), stover yield (1527 kg/ha), biological yield (2301 kg/ha) and harvest index (33.64%). Overall, integrated weed management practices involving herbicides combined with hand weeding proved superior in improving productivity and yield performance of mungbean compared to weedy check and sorgaab-based treatments. Similar findings have been reported by Sheoran *et al.* (2008), Mirijha *et al.* (2013), Singh *et al.* (2014) and Yadav *et al.* (2022).

Quality parameters

Different weed management practices significantly influenced the quality parameters (Table 6) of mungbean. The weed-free treatment (T₂) recorded the highest nitrogen content (3.94%), protein content (24.62%) and protein yield (318 kg/ha), which remained statistically at par with fluazifop-p-butyl + fomesafen @ 220 g/ha at 20 DAS + hand weeding at 30 DAS (T₆) recording 3.86% nitrogen, 24.12% protein and 292 kg/ha protein yield. Sodium-acifluorfen + clodinafop-propargyl + hand weeding (T₅) also recorded higher protein content (23.87%) and improved protein yield over weedy check. The increase in protein content under T₆ and T₅ over weedy check was 11.15 and 10.22%, respectively. Similarly, T₅ and T₉ recorded 40.50 and 38.74% higher protein yield over weedy check. In contrast, the weedy check (T₁) recorded the lowest nitrogen content (3.43%), protein content (21.43%) and protein yield (166 kg/ha).

Table 5 : Grain yield, stover yield, biological yield and harvest index of mungbean as influenced by different weed management practices.

Treatments	Grain yield (kg/ha)	Stover yield (kg/ha)	Biological yield (kg/ha)	H.I. (%)
(T ₁) Weedy check	774	1527	2301	33.64
(T ₂) Weed free	1292	2084	3376	38.27
(T ₃) Sorgaab @ 10 lit/ha (2:10) at 20 and 30 DAS	896	1646	2542	35.25
(T ₄) Sorgaab @ 10 lit/ha (2:10) at 20 DAS + H.W. at 30 DAS	1114	1926	3040	36.64
(T ₅) Acifluorfen 16.5% + clodinafop 8% @ 210 g/ha at 20 DAS + H.W. at 30 DAS	1172	1996	3168	36.99
(T ₆) Fomesafen 11.1% + fluazifop-p-butyl 11.1% @ 220 g/ha at 20 DAS + H.W. at 30 DAS	1214	2052	3266	37.17
(T ₇) Acifluorfen 16.5% + clodinafop 8% @ 210 g/ha at 20 DAS + Sorgaab conc. @ 10 lit/ha (2:10) at 30 DAS	1042	1862	2904	35.88
(T ₈) Fomesafen 11.1 % + fluazifop 11.1% + Sorgaab conc. @ 10lit/ha (2:10) at 30 DAS	1072	1904	2976	36.02
(T ₉) Imazethapyr 35 % + imazamox 35 % @ 70 g/ha at 20 DAS + H.W. at 30 DAS	1163	1982	3147	36.96
(T ₁₀) Imazethapyr 35% + imazamox 35% @ 70 g/ha at 20 DAS + Sorgaab conc. @ 10 lit/ha (2:10) at 30 DAS	1031	1846	2877	35.84
SEm±	51.9	62.8	112.9	0.94
CD (P=0.05)	154.3	186.5	335.4	NS

Table 6 : Nitrogen, Protein content and protein yield of mungbean as influenced by different weed management practices.

Treatments	Nitrogen content(%)	Protein content(%)	Protein yield (kg/ha)
(T ₁) Weedy check	3.43	21.43	166
(T ₂) Weed free	3.94	24.62	318
(T ₃) Sorgaab @ 10 lit/ha (2:10) at 20 and 30 DAS	3.51	21.93	196
(T ₄) Sorgaab @ 10 lit/ha (2:10) at 20 DAS + H.W. at 30 DAS	3.69	23.06	257
(T ₅) Acifluorfen 16.5 % + clodinafop 8 % @ 210 g/ha at 20 DAS + H.W. at 30 DAS	3.81	23.87	279
(T ₆) Fomesafen 11.1% + fluazifop-p-butyl 11.1% @ 220 g/ha at 20 DAS + H.W. at 30 DAS	3.86	24.12	298
(T ₇) Acifluorfen 16.5% + clodinafop 8% @ 210 g/ha at 20 DAS + Sorgaab conc. @ 10 lit/ha (2:10) at 30 DAS	3.59	22.44	234
(T ₈) Fomesafen 11.1 % + fluazifop 11.1% + Sorgaab conc. @ 10lit/ha (2:10) at 30 DAS	3.61	22.56	242
(T ₉) Imazethapyr 35% + imazamox 35% @ 70g/ha at 20 DAS + H.W. at 30 DAS	3.72	23.31	271
(T ₁₀) Imazethapyr 35 % + imazamox 35 % @ 70 g/ha at 20 DAS + Sorgaab conc. @ 10 lit/ha (2:10) at 30 DAS	3.63	22.69	234
SEm±	0.04	0.23	11.53
CD (P=0.05)	0.12	0.69	34.26

Overall, integrated weed management practices involving herbicides combined with hand weeding improved grain quality and protein yield of mungbean compared to weedy check. Similar results were found by Chhodavadia *et al.* (2013) and Ullah *et al.* (2022).

Conclusion

The present investigation concluded that weed management practices significantly influenced the growth, yield, and quality of mungbean [Mungbean] under semi-arid conditions of Rajasthan. Among all treatments, the weed-free treatment recorded the highest growth and yield attributes; however, it was less economical due to higher labour requirement. Among integrated weed management treatments, application of fluazifop-p-butyl 11.1% + fomesafen 11.1% SL @ 220 g/ha at 20 DAS followed by hand weeding at 30 DAS proved most effective by recording higher plant growth, nodulation, yield attributes, grain yield (1214 kg/ha), harvest index (37.17%), protein content (24.12%), and protein yield (292 kg/ha). The treatment also reduced weed competition effectively and produced 56.84% higher grain yield over weedy check. Integrated use of herbicides with hand weeding or Sargaab was found superior to individual weed control methods. Therefore, integrated weed management can be recommended as an effective, economical, and sustainable approach for enhancing mungbean productivity and quality in semi-arid regions.

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